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World Intellectual Property Organization (WIPO) - Geneva, Switzerland  
Organisation Mondiale de la Propriété Intellectuelle (OMPI) - Genève, Suisse

1325748

# THE UNITED STATES OF AMERICA

TO ALL TO WHOM THESE PRESENTS SHALL COME:

UNITED STATES DEPARTMENT OF COMMERCE

United States Patent and Trademark Office

*May 24, 2005*

**THIS IS TO CERTIFY THAT ANNEXED HERETO IS A TRUE COPY FROM THE RECORDS OF THE UNITED STATES PATENT AND TRADEMARK OFFICE OF THOSE PAPERS OF THE BELOW IDENTIFIED PATENT APPLICATION THAT MET THE REQUIREMENTS TO BE GRANTED A FILING DATE.**

**APPLICATION NUMBER: 60/566,148**

**FILING DATE: *April 27, 2004***

**RELATED PCT APPLICATION NUMBER: *PCT/US05/14514***



Certified by

Under Secretary of Commerce  
for Intellectual Property  
and Director of the United States  
Patent and Trademark Office

17231 U.S. PTO  
042704

PTO/SB/16 (01-04)

Approved for use through 07/31/2006. OMB 0651-0032

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**PROVISIONAL APPLICATION FOR PATENT COVER SHEET**

This is a request for filing a PROVISIONAL APPLICATION FOR PATENT under 37 CFR 1.53(c).

Express Mail Label No. EL919129043US

22151 U.S. PTO  
60/566148

042704

INVENTOR(S)					
Given Name (first and middle [if any])		Family Name or Surname		Residence (City and either State or Foreign Country)	
Rafael		Garcia		Tempe, Arizona	
Additional inventors are being named on the <u>1</u> separately numbered sheets attached hereto					
TITLE OF THE INVENTION (500 characters max)					
METHOD TO SYNTHESIZE LUMINESCENT SILICON-DOPED GALLIUM NITRIDE POWDERS					
Direct all correspondence to: CORRESPONDENCE ADDRESS					
<input checked="" type="checkbox"/> Customer Number: <u>28,529</u>					
OR					
<input type="checkbox"/> Firm or Individual Name					
Address					
Address					
City		State		Zip	
Country		Telephone		Fax	
ENCLOSED APPLICATION PARTS (check all that apply)					
<input checked="" type="checkbox"/> Specification Number of Pages <u>2</u>		<input type="checkbox"/> CD(s), Number _____			
<input type="checkbox"/> Drawing(s) Number of Sheets _____		<input checked="" type="checkbox"/> Other (specify) <u>postcard</u>			
<input type="checkbox"/> Application Data Sheet. See 37 CFR 1.76					
METHOD OF PAYMENT OF FILING FEES FOR THIS PROVISIONAL APPLICATION FOR PATENT					
<input checked="" type="checkbox"/> Applicant claims small entity status. See 37 CFR 1.27.				FILING FEE Amount (\$)	
<input checked="" type="checkbox"/> A check or money order is enclosed to cover the filing fees.				<u>\$80.00</u>	
<input checked="" type="checkbox"/> The Director is hereby authorized to charge filing fees or credit any overpayment to Deposit Account Number: <u>070135</u>					
<input type="checkbox"/> Payment by credit card. Form PTO-2038 is attached.					
The invention was made by an agency of the United States Government or under a contract with an agency of the United States Government.					
<input checked="" type="checkbox"/> No.					
<input type="checkbox"/> Yes, the name of the U.S. Government agency and the Government contract number are: _____					

Respectfully submitted,

SIGNATURE

TYPED or PRINTED NAME Thomas D. MacBlain

TELEPHONE 602-530-8088

[Page 1 of 2]

Date 4/27/2004

REGISTRATION NO. 24,583

(if appropriate)

Docket Number: 9138-0156

**USE ONLY FOR FILING A PROVISIONAL APPLICATION FOR PATENT**

This collection of information is required by 37 CFR 1.51. The information is required to obtain or retain a benefit by the public which is to file (and by the USPTO to process) an application. Confidentiality is governed by 35 U.S.C. 122 and 37 CFR 1.14. This collection is estimated to take 8 hours to complete, including gathering, preparing, and submitting the completed application form to the USPTO. Time will vary depending upon the individual case. Any comments on the amount of time you require to complete this form and/or suggestions for reducing this burden, should be sent to the Chief Information Officer, U.S. Patent and Trademark Office, U.S. Department of Commerce, P.O. Box 1450, Alexandria, VA 22313-1450. DO NOT SEND FEES OR COMPLETED FORMS TO THIS ADDRESS. SEND TO: Mail Stop Provisional Application, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450.

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**PROVISIONAL APPLICATION COVER SHEET**  
**Additional Page**

PTO/SB/16 (08-03)

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Docket Number 9138-0156

INVENTOR(S)/APPLICANT(S)		
Given Name (first and middle [if any] )	Family or Surname	Residence (City and either State or Foreign Country)
Fernando A.	Ponce	Tempe, Arizona
Abigail	Bell	Tempe, Arizona

[Page 2 of 2]

Number 1 of 1

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# FEE TRANSMITTAL

## for FY 2004

Effective 10/01/2003. Patent fees are subject to annual revision.

☒ Applicant claims small entity status. See 37 CFR 1.27

TOTAL AMOUNT OF PAYMENT (\$ 80

## Complete if Known

Application Number	11
Filing Date	herewith
First Named Inventor	Garcia
Examiner Name	
Art Unit	
Attorney Docket No.	9138-0156

## METHOD OF PAYMENT (check all that apply)

☒ Check ☐ Credit card ☐ Money Order ☐ Other ☐ None
☒ Deposit Account:Deposit Account Number  
Deposit Account Name

070135

Gallagher &amp; Kennedy, P.A.

The Director is authorized to: (check all that apply)

☐ Charge fee(s) indicated below ☒ Credit any overpayments☒ Charge any additional fee(s) or any underpayment of fee(s)☐ Charge fee(s) indicated below, except for the filing fee to the above-identified deposit account.

## FEE CALCULATION

## 1. BASIC FILING FEE

Large Entity		Small Entity		Fee Description	Fee Paid
Fee Code	Fee (\$)	Fee Code	Fee (\$)		
1001	770	2001	385	Utility filing fee	
1002	340	2002	170	Design filing fee	
1003	530	2003	265	Plant filing fee	
1004	770	2004	385	Reissue filing fee	
1005	160	2005	80	Provisional filing fee	80
SUBTOTAL (1)				(\$)	80

## 2. EXTRA CLAIM FEES FOR UTILITY AND REISSUE

Total Claims		-20** =		X	Fee from below	=	Fee Paid
Independent Claims		-3** =		X		=	
Multiple Dependent						=	

Large Entity		Small Entity		Fee Description	Fee Paid
Fee Code	Fee (\$)	Fee Code	Fee (\$)		
1202	18	2202	9	Claims in excess of 20	
1201	86	2201	43	Independent claims in excess of 3	
1203	290	2203	145	Multiple dependent claim, if not paid	
1204	86	2204	43	** Reissue independent claims over original patent	
1205	18	2205	9	** Reissue claims in excess of 20 and over original patent	
SUBTOTAL (2)				(\$)	

\*\*or number previously paid, if greater; For Reissues, see above

## 3. ADDITIONAL FEES

Large Entity Small Entity

Fee Code	Fee (\$)	Fee Code	Fee (\$)	Fee Description	Fee Paid
1051	130	2051	65	Surcharge - late filing fee or oath	
1052	50	2052	25	Surcharge - late provisional filing fee or cover sheet	
1053	130	1053	130	Non-English specification	
1812	2,520	1812	2,520	For filing a request for ex parte reexamination	
1804	920*	1804	920*	Requesting publication of SIR prior to Examiner action	
1805	1,840*	1805	1,840*	Requesting publication of SIR after Examiner action	
1251	110	2251	55	Extension for reply within first month	
1252	420	2252	210	Extension for reply within second month	
1253	950	2253	475	Extension for reply within third month	
1254	1,480	2254	740	Extension for reply within fourth month	
1255	2,010	2255	1,005	Extension for reply within fifth month	
1401	330	2401	165	Notice of Appeal	
1402	330	2402	165	Filing a brief in support of an appeal	
1403	290	2403	145	Request for oral hearing	
1451	1,510	1451	1,510	Petition to institute a public use proceeding	
1452	110	2452	55	Petition to revive - unavoidable	
1453	1,330	2453	665	Petition to revive - unintentional	
1501	1,330	2501	665	Utility issue fee (or reissue)	
1502	480	2502	240	Design issue fee	
1503	640	2503	320	Plant issue fee	
1460	130	1460	130	Petitions to the Commissioner	
1807	50	1807	50	Processing fee under 37 CFR 1.17(q)	
1806	180	1806	180	Submission of Information Disclosure Stmt	
8021	40	8021	40	Recording each patent assignment per property (times number of properties)	
1809	770	2809	385	Filing a submission after final rejection (37 CFR 1.129(a))	
1810	770	2810	385	For each additional invention to be examined (37 CFR 1.129(b))	
1801	770	2801	385	Request for Continued Examination (RCE)	
1802	900	1802	900	Request for expedited examination of a design application	

Other fee (specify)

\*Reduced by Basic Filing Fee Paid

SUBTOTAL (3) (\$)

## SUBMITTED BY

(Complete (if applicable))

Name (Print/Type)	Thomas D. MacBlain	Registration No. (Attorney/Agent)	24,583	Telephone	602-530-8088
Signature		Date	4/27/2004		

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If you need assistance in completing the form, call 1-800-PTO-9199 and select option 2.

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

Applicant: Garcia et al.

Filed: Herewith

Title: **METHOD TO SYNTHESIZE LUMINESCENT SILICON-DOPED GALLIUM  
NITRIDE POWDERS**

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**CERTIFICATE OF MAILING BY EXPRESS MAIL  
"Express Mail" mailing label number EL919129043US**

Mail Stop Provisional Patent Application  
Commissioner for Patents  
P.O. Box 1450  
Alexandria, VA 22313-1450

Dear Commissioner:

I hereby certify that the following correspondence is being deposited in the United States Postal Service as Express Mail on the date shown below in an envelope addressed as shown above.

1. Provisional Application for Patent Cover Sheet (2 pages);
2. Fee Transmittal for FY 2004 (1 page in duplicate);
3. Specification (2 pages plus cover sheet);
4. Check for \$80.00; and
5. A return receipt postcard.

4/27/04  
Date

Suzanne Shields  
Suzanne Shields

GALLAGHER & KENNEDY, P.A.  
2575 East Camelback Road  
Phoenix, Arizona 85016-9255  
Tel. No. (602) 530-8000  
Fax. No. (602) 530-8500

Express Mail Label No. EL919129043US

**IN THE UNITED STATES PATENT AND TRADEMARK OFFICE**

**Provisional Patent Application**

**Title:**                   **METHOD TO SYNTHESIZE LUMINESCENT SILICON-DOPED  
GALLIUM NITRIDE POWDERS**

**Inventor(s):**       Rafael Garcia, Tempe, Arizona  
Fernando A. Ponce, Tempe, Arizona  
Abigail Bell, Tempe, Arizona

**Attorneys for Applicant:**   Thomas D. MacBlain  
Donna H. Catalfio  
Gallagher & Kennedy, P.A.  
2575 East Camelback Road  
Phoenix, AZ 85016-9225

## METHOD TO SYNTHESIZE LUMINESCENT SILICON-DOPED GALLIUM NITRIDE POWDERS

The problem which this invention solves is:

1. Low quality in n-type gallium nitride powders; and
2. Doping and co-doping GaN-powders for electroluminescent devices.

We have developed a new method to produce silicon-doped gallium nitride powders.

This method has a high control over the concentration of silicon in the final product. The method consists in reacting a gallium-silicon alloy with ultra-high purity ammonia in a horizontal quartz tube reactor at 1200°C curing 1.5 hours.

The gallium-silicon alloy is prepared using a mechanical mixer. Ultra-high purity gallium melt and silicon powder are placed in a stainless steel sealed vessel under vacuum at a selected temperature (e.g. 500°C) and the vessel is mechanically mixed for several hours in order to produce a highly homogeneous alloy. A variant to this invention is to place the gallium melt in contact with a silicon crystal (like the melt on top of a silicon wafer, or dipping a silicon crystal on the melt) and increasing the temperature to a value that results in the desired solubility of silicon (according to the Ga-Si phase diagram). The gallium-silicon alloy is then removed and reacted as previously described. An ultrasonic agitator may be used to accelerate the solubility process.

We have been working on the synthesis of gallium nitride and related compounds as part of a GaN microcrystalline powder project supported by a gift from Durel Corporation (now a division of Rogers Corporation). Professor Fernando A. Ponce and I (Rafael Garcia) planned my second year of postdoctoral stay at Arizona State University (ASU), this second year with the emphasis on learning how to dope such GaN powders. This work is of high scientific as well as technological importance. Durel's gift allowed us to explore directions which were not mainstream to current technology. The importance of these powders is in their potential as electroluminescent phosphors. The first stage involved production of GaN powders with high crystalline quality and high light emission efficiency. The second stage involved learning to dope such powders. We started with a new series of experiments using silicon as a donor agent and we found that it is possible to produce silicon doped gallium nitride powder using a gallium-silicon alloy as a precursor. We also found that through this method it is possible to control the

concentration of silicon in the gallium nitride powders. The material produced resulted in surprisingly high silicon-related luminescence.

This invention can be used as a method to produce n-type doped phosphors that could be used as active material in electroluminescent devices.